NORTH DAKOTA

Sampling for Site-Specific Farming: Topography and Nutrient Considerations

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North Dakota farmers have begun using site-specific technology to fine-tune fertilizer rates and other production practices. Currently, one of the driving forces behind variable-rate fertilizer application is sugarbeet production. Sugarbeet profits come from both yield and sugar content.

Nitrogen (N) is very important to achieve high yields, but excess N decreases the concentration of sugar and increases impurities, reducing premiums paid to producers. Variable-rate N fertilization has helped maintain high yields while increasing sugar content, making it a highly profitable tool for sugarbeet growers.

Studies in the northern Great Plains are indicating substantial within-field variability of several nutrients. Preliminary indications are that topography may be an important consideration in sampling these fields for variable rate fertilizer application.

Although sugarbeet production is important in eastern North Dakota, many other crops grown throughout the state rely on proper N fertility to produce the yields and quality necessary for grower profitability. They include hard red spring wheat, durum wheat, malting barley, dry bean, canola and potato. These crops are grown on over 80 percent of the non-hay crop land in North Dakota.

North Dakota has a very successful fall/spring soil nitrate testing program. Because of the long winters, fall or spring nitrate testing is an effective tool that allows producers to predict N needs far in advance of crop production.

TABLE 1. Correlation of zero to 2 ft. NO_3-N in a 110 ft. grid with estimates from less dense grid patterns.

Grid size	Valley City	Gardner
	r	
220 ft.	0.175	0.513
330 ft.	0.065	0.351
5 acres	0.073	0.158

North Dakota Studies

Two square 40 acre fields were sampled in the fall of 1994 in a 110 ft. grid. The first field, located near Gardner, represented a typical level Red River Valley landscape. Soil cores were taken to a 4 ft. depth and divided into 0-6 in., 6-24 in., and 24-48 in. increments. Sodium bicarbonate extractable phosphorus (Olsen P), pH, zinc (Zn), organic matter and potassium (K) were determined on the 0-6 in. sample. Sulfate and chloride (Cl) were determined on the 0-6 in. and 6-24 in. samples, and nitrate-N (NO_3-N) was analyzed for all depths. The second field was located south of Valley City and represented the glacial till plain soil groups which are typified by variability in landscape and texture. Soil samples were taken at the 0-6 in. and 6-24 in. depth and analyzed as indicated.

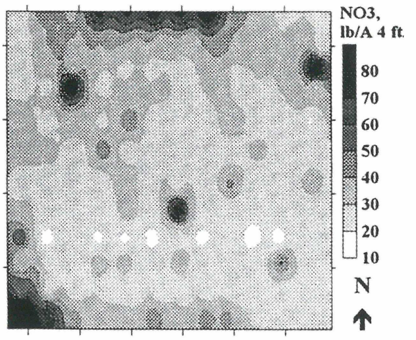

FIGURE 1. Nitrate-N levels at the Gardner field in 1995 varied from 15 to 169 lb/A.

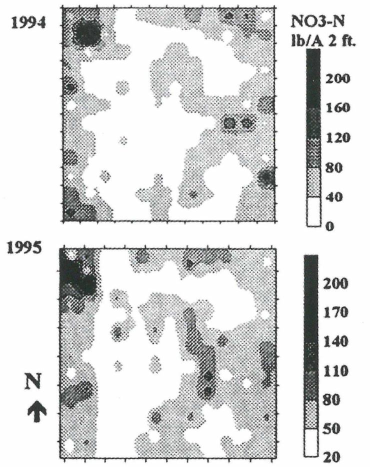

FIGURE 2. Comparison of Valley City nitrate-N between 1994 and 1995.

Sampling at both locations was repeated in the fall of 1995.

In 1995, two additional fields were sampled, a square 40 acre field near Colfax on the western edge of the Red River Valley and an approximately 80 acre field located at the USDA-ARS Research Center near Mandan. Samples were taken from Colfax in the same manner as the Gardner site. Samples at Mandan were taken to a 2 ft. depth and separated as at Valley City. The Mandan site was divided into west, center and east fields. The east field was sampled in a 110 ft. grid, while the center and west were sampled in 150 ft. grids. Maps were produced using inverse distance squared weighting.

Despite the uniform appearance of the Gardner field, NO_3-N levels varied in 1994 from 9 to 274 lb/A in the top 48 in. and 15 to 169 lb/A in 1995 (**Figure 1**). Soil NO_3-N levels seem to follow patterns of surface grading for drainage within the field.

The Valley City field was more variable in topography and nutrient levels than the Gardner field. Nitrate-N levels to 2 ft. varied from 4 to 554 lb/A in 1994

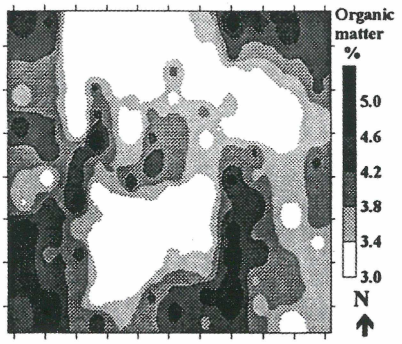

FIGURE 3. Valley City organic matter levels, 1995.

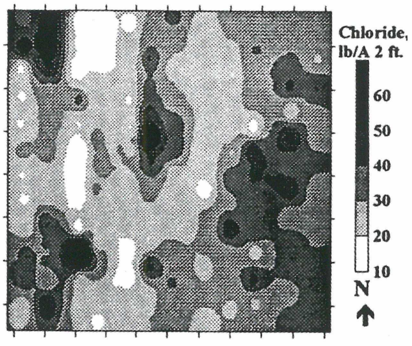

FIGURE 4. Valley City chloride levels, 0-2 ft., 1995.

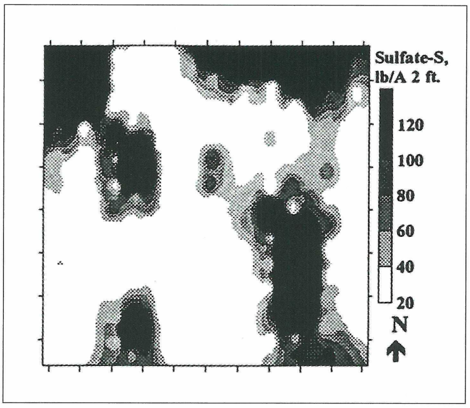

FIGURE 5. Valley City sulfate-S levels, 0-2 ft., 1995.

and 9 to 374 lb/A in 1995 (**Figure 2**). Organic matter content is a reflection of topography at Valley City (**Figure 3**). Valley City NO_3-N levels appear to follow similar patterns to organic matter. Other evidence to support a topographic relationship is the similarity of NO_3-N levels between 1994 and 1995 (**Figure 2**). Similarities are present despite a uniform application of 100 lb N/A and removal of a 2,000 lb/A sunflower crop in 1995. Not only does NO_3-N appear to be related to topography, but Cl and sulfate (**Figures 4 and 5**) also appear to be related to landscape position.

Grid sizes at Gardner and Valley City were compared in 1994. Grid sampling

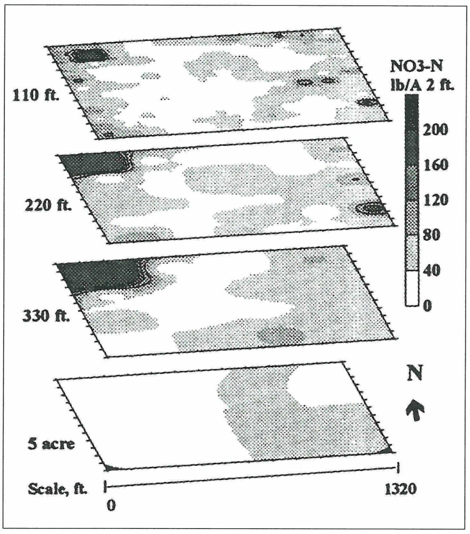

FIGURE 6. Soil nitrate-N, Valley City as represented by different sampling grids.

was better correlated in the more level landscape at Gardner than in the rolling landscape at Valley City. A 4 acre grid at Gardner was nearly as representative of 110 ft. grid NO_3-N values as a 220 ft. grid at Valley City (**Table 1**). Decreasing grid density at Valley City resulted in less boundary definition and poor field representation (**Figure 6**).

The organic matter map is a reflection of the general topography of the field at Colfax (**Figure 7**). The NO_3-N map of

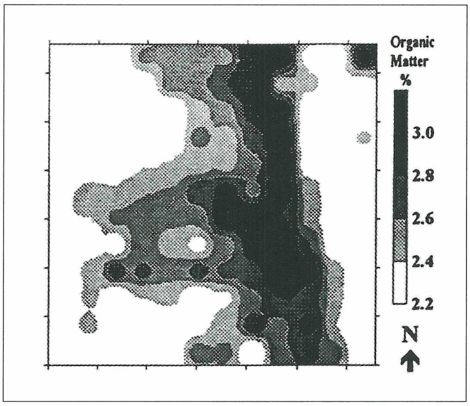

FIGURE 7. Colfax field organic matter, 1995.

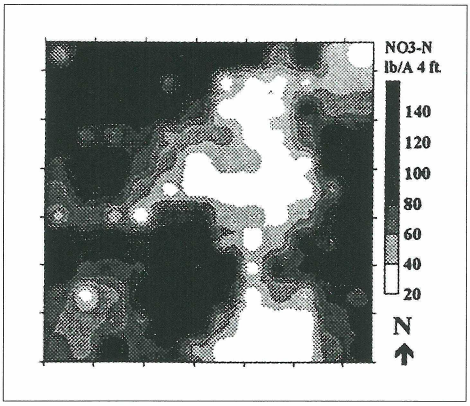

FIGURE 8. Colfax field nitrate-N to 4 ft., 1995.

Colfax (**Figure 8**) shows an inverse relationship with organic matter/topography.

Topography was measured by using laser relative elevation readings at 110 ft. intervals in the field at Mandan. Fourteen NO_3-N values were selected to represent the field for the topographic/cropping estimates. The correlation coefficient between NO_3-N sampled on a 110 to 150 ft. grid and NO_3-N sampled on a 1 to 2 acre grid was 0.290. Nitrate-N sampled by topography/cropping pattern had a correlation coefficient of 0.755 with the 110 to 150 ft. grid and showed substantial superiority over grid sampling for this field.

In 1996, topographic variation will be measured at all sites and more rigorous testing of the influence of topography on fertility levels will be examined. Yield monitors will be used at crop harvest at Mandan and Colfax. The profitability of site-specific sampling and fertilizer application will be explored at two of the sites.

Summary

The initial results of these studies indicate topography may play an important part in soil sampling for variable-rate fertilizer application. More research is needed to verify the preliminary observations. BC

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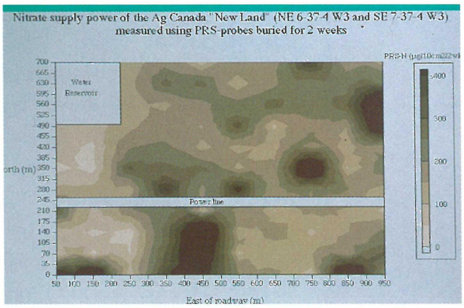
Soil Nutrient Supply Rates…(continued from page 13)



MAP shows nitrate supply rate for a 150 acre field near Saskatoon.

for a 150 acre field near Saskatoon, Sask. A grid was laid out with 104 measurement points, and the PRS burial and retrieval carried out as described previously. The nitrate, phosphate and sulfate adsorbed on anion exchange probes over a two week burial were used to calculate potential nutrient supply rate differences within the field. The values were then entered into Rockware™ on an Apple Macintosh computer.

Variations in nutrient supply rate across the field revealed the expected differences related to topography and management effects. Low-lying areas of the field, where eroded soil had accumulated and organic matter and soil moisture are higher, showed the expected higher nutrient supply rates than eroded upslope areas. The influence of past management was also evident in a portion of the field revealing high nitrate and sulfate supply rates related to the fact it was previously in grass and only recently brought under cultivation.

Because it eliminates the need to collect, handle and process many soil samples while providing a unique indication of nutrient supplying power under field conditions, we believe the PRS method is a potentially valuable tool in field fertility mapping for site-specific fertility management. BC

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